

CHAPTER 2 (Odd)

$$3. \quad a. \quad r = 1 \text{ m}: F = \frac{kQ_1Q_2}{r^2} = \frac{(9 \times 10^9)(1 \mu\text{C})(2 \mu\text{C})}{(1 \text{ m})^2} \\ = \frac{(9 \times 10^9)(2 \times 10^{-12})}{1} = \frac{18 \times 10^{-3}}{1} = 18 \text{ mN}$$

$$b. \quad r = 3 \text{ m}: F = \frac{18 \times 10^{-3}}{(3)^2} = \frac{18 \times 10^{-3}}{9} = 2 \text{ mN}$$

$$c. \quad r = 10 \text{ m}: F = \frac{18 \times 10^{-3}}{(10)^2} = \frac{18 \times 10^{-3}}{100} = 180 \mu\text{N}$$

$$5. \quad F = \frac{kQ_1Q_2}{r^2} = \frac{(9 \times 10^9)(2 \text{ mC})(4 \mu\text{C})}{r^2} = \frac{72}{r^2}$$

$$r = 0.5 \text{ m}, F = \frac{72}{(0.5)^2} = 288 \text{ N}$$

$$r = 1 \text{ m}, F = \frac{72}{(1)^2} = 72 \text{ N}$$

$$r = 5 \text{ m}, F = \frac{72}{(5)^2} = 2.88 \text{ N}$$

$$r = 10 \text{ m}, F = \frac{72}{(10)^2} = 0.72 \text{ N}$$

$$7. \quad F = \frac{kQ_1Q_2}{r^2} \Rightarrow 1.8 = \frac{kQ_1Q_2}{(2 \text{ m})^2} \Rightarrow kQ_1Q_2 = 4(1.8) = 7.2$$

$$a. \quad F = \frac{kQ_1Q_2}{r^2} = \frac{7.2}{(10)^2} = 72 \text{ mN}$$

$$b. \quad Q_1/Q_2 = 1/2 \Rightarrow Q_2 = 2Q_1$$

$$7.2 = kQ_1Q_2 = (9 \times 10^9)(Q_1)(2Q_1) = 9 \times 10^9(2Q_1^2)$$

$$\frac{7.2}{18 \times 10^9} = Q_1^2 \Rightarrow Q_1 = \sqrt{\frac{7.2}{18 \times 10^9}} = 20 \mu\text{C}$$

$$Q_2 = 2Q_1 = 2(2 \times 10^{-5} \text{ C}) = 40 \mu\text{C}$$

$$9. \quad I = \frac{Q}{t} = \frac{465 \text{ C}}{(2.5)(60 \text{ s})} = 3.1 \text{ A}$$

$$11. \quad Q = It = (750 \times 10^{-3} \text{ A})(120 \text{ s}) = 90 \text{ C}$$

$$13. \quad 21.847 \times 10^{18} \text{ electrons} \left[\frac{1 \text{ C}}{6.242 \times 10^{18} \text{ electrons}} \right] = 3.5 \text{ C}$$

$$I = \frac{Q}{t} = \frac{3.5 \text{ C}}{7 \text{ s}} = 0.5 \text{ A}$$

$$15. \quad I = \frac{Q}{t} = \frac{86 \text{ C}}{(1.2)(60 \text{ s})} = 1.194 \text{ A} > 1 \text{ A (yes)}$$

$$17. \quad \text{a.} \quad Q = It = (2 \text{ mA})(0.01 \mu\text{s}) = 2 \times 10^{-11} \text{ C}$$

$$2 \times 10^{-11} \cancel{\text{C}} \left[\frac{6.242 \times 10^{18} \text{ electrons}}{1 \cancel{\text{C}}} \right] \left[\frac{1 \text{ ¢}}{\text{electron}} \right] \\ = 1.248 \times 10^8 \text{ ¢} = \$1.248 \times 10^6 = \mathbf{1.248 \text{ million}}$$

$$\text{b.} \quad Q = It = (100 \mu\text{A})(1.5 \text{ ns}) = 1.5 \times 10^{-13} \text{ C}$$

$$1.5 \times 10^{-13} \cancel{\text{C}} \left[\frac{6.242 \times 10^{18} \text{ electrons}}{1 \cancel{\text{C}}} \right] \left[\frac{\$1}{\text{electron}} \right] = \$936,300 = \mathbf{0.9363 \text{ million}}$$

(a) > (b)

$$19. \quad W = VQ = (42 \text{ V})(6 \text{ C}) = \mathbf{252 \text{ J}}$$

$$21. \quad Q = \frac{W}{V} = \frac{90 \text{ J}}{22.5 \text{ V}} = 4 \text{ C}$$

$$23. \quad Q = It = \left[\frac{420 \text{ C}}{\text{min}} \right] (0.5 \text{ min}) = 210 \text{ C}$$

$$V = \frac{W}{Q} = \frac{742 \text{ J}}{210 \text{ C}} = \mathbf{3.53 \text{ V}}$$

$$25. \quad I = \frac{\text{Ah rating}}{t(\text{hours})} = \frac{200 \text{ Ah}}{40 \text{ h}} = 5 \text{ A}$$

$$27. \quad t(\text{hours}) = \frac{\text{Ah rating}}{I} = \frac{32 \text{ Ah}}{1.28 \text{ A}} = \mathbf{25 \text{ h}}$$

$$29. \quad \text{From Fig. 2.18a} \cong 425 \text{ mAh}$$

$$t(\text{hours}) = \frac{\text{mAh rating}}{I(\text{mA})} = \frac{425 \text{ mAh}}{550 \text{ mA}} = \mathbf{0.773 \text{ h}}$$

$$31. \quad 1 \text{ h: } I_1 = \frac{40 \text{ Ah}}{1 \text{ h}} = 40 \text{ A}$$

$$I_2 = \frac{60 \text{ Ah}}{1 \text{ h}} = 60 \text{ A}$$

60 A: 40 A \Rightarrow 1.5:1 (50% more)

$$33. \quad I = \frac{3 \text{ Ah}}{5.5 \text{ h}} = 545.45 \text{ mA}$$

$$Q = It = (545.45 \text{ mA})(5.5 \text{ h}) \left[\frac{60 \text{ min}}{1 \text{ h}} \right] \left[\frac{60 \text{ s}}{1 \text{ min}} \right] = 10,799.91 \text{ C}$$

$$W = QV = (10,799.91 \text{ C})(12 \text{ V}) \cong 129.6 \text{ kJ}$$

$$43. \quad 4 \text{ min} \left[\frac{60 \text{ s}}{1 \text{ min}} \right] = 240 \text{ s}$$

$$Q = It = (2.5 \text{ A})(240 \text{ s}) = 600 \text{ C}$$

CHAPTER 2 (Even)

$$\begin{aligned}
 2. \quad F &= \frac{kQ_1Q_2}{r^2} = \frac{(9 \times 10^9)(1.6 \times 10^{-19}\text{C})^2}{(5 \times 10^{-11}\text{ m})^2} \\
 &= \frac{23.04 \times 10^9 \times 10^{-38}}{25 \times 10^{-22}} = \frac{23.04}{25} \times 10^{-7} = \mathbf{0.092 \mu\text{N}}
 \end{aligned}$$

$$4. \quad \text{a.} \quad r = 1 \text{ mi:}$$

$$\begin{aligned}
 1 \cancel{\mu\text{f}} \left[\frac{5280 \cancel{\text{ft}}}{1 \cancel{\mu\text{f}}} \right] \left[\frac{12 \cancel{\mu\text{f}}}{1 \cancel{\text{ft}}} \right] \left[\frac{1 \text{ m}}{39.37 \cancel{\mu\text{f}}} \right] &= 1609.35 \text{ m} \\
 F &= \frac{kQ_1Q_2}{r^2} = \frac{(9 \times 10^9)(8 \times 10^{-6}\text{ C})(40 \times 10^{-6}\text{ C})}{(1609.35 \text{ m})^2} = \frac{2880 \times 10^{-3}}{2.59 \times 10^6} \\
 &= \mathbf{1.11 \mu\text{N}}
 \end{aligned}$$

$$\text{b.} \quad r = 0.01 \text{ m:}$$

$$F = \frac{kQ_1Q_2}{r^2} = \frac{2880 \times 10^{-3}}{(10^{-2})^2} = \frac{2880 \times 10^{-3}}{10^{-4}} = 2880 \times 10^1 = \mathbf{28.8 \text{ kN}}$$

$$\text{c.} \quad \frac{1 \cancel{\mu\text{f}}}{16} \left[\frac{1 \text{ m}}{39.37 \cancel{\mu\text{f}}} \right] = 1.59 \text{ mm}$$

$$\begin{aligned}
 F &= \frac{kQ_1Q_2}{r^2} = \frac{2880 \times 10^{-3}}{(1.59 \times 10^{-3} \text{ m})^2} = \frac{2880 \times 10^{-3}}{2.53 \times 10^{-6}} = 1138.34 \times 10^3 \text{ N} \\
 &= \mathbf{1138.34 \text{ kN}}
 \end{aligned}$$

$$6. \quad F = \frac{kQ_1Q_2}{r^2} \Rightarrow r = \sqrt{\frac{kQ_1Q_2}{F}} = \sqrt{\frac{(9 \times 10^9)(20 \times 10^{-6})^2}{3.6 \times 10^4}} = \mathbf{10 \text{ mm}}$$

$$8. \quad I = \frac{Q}{t} = \frac{650 \text{ C}}{50 \text{ s}} = \mathbf{13 \text{ A}}$$

$$10. \quad Q = It = (40 \text{ A})(60 \text{ s}) = \mathbf{2400 \text{ C}}$$

$$12. \quad t = \frac{Q}{I} = \frac{4600 \times 10^{-6} \text{ C}}{2 \times 10^{-3} \text{ A}} = \mathbf{2.3 \text{ s}}$$

$$14. \quad Q = It = (1 \text{ A})(60 \text{ s}) = 60 \text{ C}$$

$$60 \text{ C} = 60(6.242 \times 10^{18} \text{ electrons}) = \mathbf{374.52 \times 10^{18} \text{ electrons}}$$

$$16. \quad 0.784 \times 10^{18} \cancel{\text{electrons}} \left[\frac{1 \text{ C}}{6.242 \times 10^{18} \cancel{\text{electrons}}} \right] = 0.1256 \text{ C}$$

$$I = \frac{Q}{t} = \frac{0.1256 \text{ C}}{643 \times 10^{-3} \text{ s}} = \mathbf{195 \text{ mA}}$$

$$18. \quad 50 \times 10^{18} \text{ electrons} \left[\frac{1 \text{ C}}{6.242 \times 10^{18} \text{ electrons}} \right] = 8.01 \text{ C}$$

$$V = \frac{W}{Q} = \frac{96 \times 10^{-3} \text{ J}}{8.01 \text{ C}} = 11.985 \text{ mV}$$

$$20. \quad Q = \frac{W}{V} = \frac{96 \text{ J}}{16 \text{ V}} = 6 \text{ C}$$

$$22. \quad Q = It = (200 \times 10^{-3} \text{ A})(30 \text{ s}) = 6 \text{ C}$$

$$V = \frac{W}{Q} = \frac{40 \text{ J}}{6 \text{ C}} = 6.67 \text{ V}$$

$$24. \quad Q = \frac{W}{V} = \frac{0.4 \text{ J}}{24 \text{ V}} = 0.0167 \text{ C}$$

$$I = \frac{Q}{t} = \frac{0.0167 \text{ C}}{5 \times 10^{-3} \text{ s}} = 3.34 \text{ A}$$

$$26. \quad \text{Ah} = [0.8 \text{ A}][76 \text{ h}] = 60.8 \text{ Ah}$$

$$28. \quad @ 100^\circ\text{F} \cong 475 \text{ mAh}$$

$$@ 0^\circ\text{C}(32^\circ\text{F}) \cong 455 \text{ mAh}$$

$$30. \quad \text{From Fig. 2.19} \cong 10.4 \text{ h @ } 50 \text{ mA}$$

$$\cong 3.4 \text{ h @ } 150 \text{ mA}$$

$$150 \text{ mA} : 50 \text{ mA} = 3:1$$

$$3.4 \text{ h} : 10.4 \text{ h} = 1:3$$

An increase in drain current by a factor of three decreases the time availability to about one-third.

$$32. \quad \text{For 1 hour, } I = 500 \text{ mA}$$

$$Q = It = (500 \text{ mA})(1 \text{ h}) \left[\frac{60 \text{ min}}{1 \text{ h}} \right] \left[\frac{60 \text{ s}}{1 \text{ min}} \right] = (500 \times 10^{-3} \text{ A})(3600 \text{ s}) = 1800 \text{ C}$$

$$W = VQ = (1.2 \text{ V})(1800 \text{ C}) = 2160 \text{ J}$$

$$44. \quad Q = It = (10 \times 10^{-3} \text{ A})(20 \text{ s}) = 200 \text{ mC}$$

$$W = VQ = (12.5 \text{ V})(200 \times 10^{-3} \text{ C}) = 2.5 \text{ J}$$